The identity of the female of *Antheraea diehli* Lemaire, 1979 (Lepidoptera, Saturniidae)

Dave Rolfe and Stefan Naumann

Dave Rolfe, 15, Dene Holm Road, Northfleet, Kent, DA11 8LF, England; bug.shell@yahoo.co.uk
Dr. Stefan Naumann, Hochkirchstrasse 11, D-10829 Berlin, Germany; sn@saturniidae.com

Abstract: An overview of the handling of *A. diehli* Lemaire, 1979 in literature is given. The so far questionable status of its female is fixed by DNA sampling of both male and female specimens. Within those studies, also the status of *A. imperator* Watson, 1913 and *A. borneensis* Moore, 1892, **stat. rev.**, on species level is confirmed. With knowledge of the identity of *A. diehli* female, some hitherto unknown specific characters could be worked out which make the determination and separation from its syntope occuring *A. borneensis* simple. A list with collecting data of the so far known specimens of the rare *A. diehli* is mentioned at the end of that work.

Key words: *Antheraea*, *helferi*-group, *diehli*, *imperator*, *borneensis*, revised status, determination via DNA sampling, data compilation.

Die Identität des Weibchens von *Antheraea diehli* Lemaire, 1979 (Lepidoptera, Saturniidae)

Zusammenfassung: Es wird eine Übersicht über die Behandlung von *A. diehli* Lemaire, 1979 in der Literatur gegeben. Der bisher fragliche Status des Weibchens wird durch DNA-Analysen bestätigt, so daß eine Zuordnung der Weibchen zum entsprechenden Männchen möglich ist. Im Rahmen dieser Studien wurde auch der jeweilige Artstatus von *A. imperator* Watson, 1913 und *A. borneensis* Moore, 1892, **stat. rev.**, bestätigt. Durch die Kenntnis der wirklichen Identität der Weibchen von *A. diehli* konnten nach einer Falterserie bisher unklare spezifische Merkmale herausgearbeitet werden, die eine Bestimmung und Abgrenzung von der syntop vorkommenden *A. borneensis* einfacher machen. Am Ende der Arbeit präsentieren wir zur Übersicht eine Liste mit Daten der bisher bekannten Falter der seltenen Art *A. diehli*.

Introduction

Until recently, the standing of *A. diehli* within the *helferi*-group of the genus *Antheraea* so far was somewhat tenuous, and among different authors the identification of the ♀ was considered to be open to debate. By chance, a photo of ♂ and ♀ specimens of that taxon were presented by the senior author to the junior author a short time ago. This immediately made the similar pecularities of both sexes obvious; specimens were collected several years ago in Borneo and since then have been located in British collections. Only very recently the junior author received the collecting results of an expedition to Central Kalimantan, and also here was, aside from typical *A. borneensis* Moore, 1892, **stat. rev.**, a nice series of ♀♀ with same characters as those of the older specimen included, which makes differences between *A. diehli* and *A. borneensis* even more evident.

Collection abbreviations used

CDRN	Collection Dave Rolfe, Northfleet, Great Britain.
CRLN	Collection Rudolf E. J. Lampe, Nürnberg, Germany.
CSLL	Collection Swen Löffler, Lichtenstein/Sachsen, Germany.
CSNB	Collection Dr. Stefan Naumann, Berlin, Germany.
MNHN	Musée National d'Histoire naturelle, Paris, France.
BMNH	The Natural History Museum (formerly British Museum (Natural History)), London, Great Britain.
SMFL	Senckenberg-Museum, Lepidoptera Section, Frankfurt am Main, Germany (including former private collection of W. A. Nässig).

Further abbreviations

fw.	Forewing[s].
hw.	Hindwing[s].
lfw.	Length of forewing, measured in a straight line from the wing base to the most distant point of the apex.

Handling in literature

A. diehli is a typical Sundaland representative of the genus; it was described from Sungei Dareh, E Padang, 700 m, Padangsche Bovenlanden, Sumatra Island, Indonesia (Lemaire 1979: 89; ♂ holotype ex coll. Lemaire in Musée National d'Histoire naturelle, Paris; examined, S.N.), but since then also recorded from the island of Borneo (Allen 1981: 115, record for Brunei; Holloway *in* Barlow 1982: 194 & Holloway 1987: 100, records for Brunei; Nässig & Beck 2005: 181, record for Sabah; Naumann & Lourens 2008: 65, record for Kalimantan), West Malaysia (Lampe 1984: 9, Lampe 1985: 11), and again Sumatra Island (Nässig et al. 1996a: 60). The determination of a ♀ collected on Nias Island west of the Sumatran coastline (Buchsbaum & Brüggemeier 1996: 172) should be correct, judging from the photo in Nässig at al. (1996a: 103, fig. 80) but should be verified by DNA analysis of the ♀ singleton. Photos of the eggshell surface published by Buchsbaum & Brüggemeier (1996) were also used for the phylogenetic study based on eggshell morphogenesis by Regier et al. (2005). Old records of *A. diehli* from the island of Java, mentioned also in Nässig et al. (1996a: 60), should be verified by DNA analysis as well, since no recent records from that island exist. A survey about published records and critical annotations was published by Paukstadt & Paukstadt (2007: 224 *ff.*).

Following the description of the species after a series of 4 ♂♂, there was a discussion about the true identity of the ♀♀ of *A. diehli*, which sometimes were not correctly classified in literature. Shortly after description, Allen

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(1981) published already a photo with a pair of *A. diehli;* this photo was so small that, although of correct identity, his classification was not always followed; Holloway *in* Barlow (1982), who obviously knew Allen's series from Brunei, and not figuring the ♀, described it so accurately, that we cite him directly below:

> "♀♀, described here for the first time, 90 and 98 mm. The ground colour is a less orange yellow than in *helferi borneensis* and the faint, diffuse orange postmedial on the upperside of *borneensis* is absent in *diehli*. As in the male, the medial fascia of the hindwing is associated with the ocellus rather then well separated. The hindwing ocelli are larger, more elliptical, less clearly marked and less orange over the interior half than in *borneensis*. On the underside *borneensis* is generally darker and more emphatically marked, particularly on the ocelli. The most reliable diagnostic charcteristics are those involving the ocelli, particularly those of the hindwing."

As we now have a series of 7 ♀♀ (see Figs. 1–3) in our hands, we can add some information about the reliability and usefulness of certain characters for determination. Further characters make a separation of the ♀♀ easily possible:

- *A. diehli* is larger on average (lfw. 85–98 mm) than *A. borneensis* (76–86 mm).
- The ground colour of *A. diehli* is a paler and lighter yellow.
- The postmedian line of *A. diehli* is absolutely straight and not bent.
- The fw. apex of *A. diehli* has a little less rectangular form.
- The antemedian line of the fw. of *A. diehli* is always of purplish black colour, not pink as in *A. borneensis,* and on the hw. it ends above the ocellus, whereas it circles it in *A. borneensis*.
- The postmedian is followed by a paler whitish violet margin compared to a broader pink one in *A. borneensis,* and the hw. postmedian area shows a row of fainted shadows.
- On ventral side the white portions of both fw. and hw. ocellus and the row of postmedian bluish white triangles are quite similar to the ♂♂; the triangles are black in *A. borneensis*.
- The wing ocelli of *A. borneensis* bear a complete white ring, whereas they do not in *A. diehli*.
- The antennae of *A. diehli* ♀♀ have a length of 13–15 mm (*A. borneensis:* 15–16.5 mm) with 30–32 segments (*A. borneensis:* 34–35).

The fw. ocellus of *A. diehli* has a maximum diameter of 9.5–14 mm (*A. borneensis:* 8.5–14 mm), that of the hw. 11–13.5 mm (*A. borneensis:* 11–14 mm); this is therefore not a very significant character. Other insignificant characters for determination are the fw. connection between costa and ocellus which in both taxa is more or less present, and the size of the translucent part of the fw. ocellus.

Recent DNA sampling of a ♂ (barcode SNB 0050) and a ♀ (barcode SNB 1134) specimen within the BOLD project (Barcode of Life, University of Guelph) showed the conspecificity of the specimens involved and placed *A. diehli* as closely related to the almost continental *A. yamamai* (Guérin-Méneville, 1861) and *A. hagedorni* Naumann & Lourens, 2008 from Luzon Island, Philippines; this was already expected by the latter authors. Astonishingly, the sister species to this complex turned out to be *A. larissa* (Westwood, 1847), but as this result is based only on a short section of one gene, it might not necessarily be significant.

During recent barcoding studies the specific status of *A. imperator* Watson, 1913 from Java was also confirmed; this had been postulated by the author of that taxon and some following authors (compare Paukstadt & Paukstadt 2000: 51), but lateron it was synonymized with *A. helferi* Moore, 1859 by Allen (1981: 114) and reinstated into species rank by Paukstadt & Paukstadt (2000: 51). The same specific status is supported by the studies for *A. borneensis* **stat. rev.**, which clearly could be found separated from the Himalayan and northern Thailand populations which are typical *A. helferi* in the sense of the original description. Both ♂♂ and ♀♀ specimens of *A. borneensis* (holotype see Figs. 4, 5) differ from *A. helferi* by their larger size on average, larger ocelli, and more colourful pattern, in the ♂♂ partly with strongly indicated veins.

With knowledge of that the determinations of *A. diehli* ♀♀ in literature published after Holloway *in* Barlow (1982) can easily be reviewed. The figured ♀ in Lampe (1984: pl. 4, fig. 1; 1985: pl. 4, fig. 1) is *A. borneensis,* while the ♂ is a true *A. diehli*. Holloway (1987: 100, pl. 13, fig. 4) figures a true *A. diehli,* although he indicates that the assignment of ♀♀ to the species is somewhat tentative. The living ♀ figured by Heppner (1993: 2) from Sumatra is a typical *A. borneensis* and thereby misidentified. Notes on the citation by Buchsbaum & Brüggemeier (1996) from Nias and that of Nässig et al. (1996a) from West Java were given already above; both records should be verified by DNA analysis. The brownish ♀ from Sabah figured by Nässig & Schulze (1997: 153) is an *A. borneensis* specimen, as indicated already by the authors. In Nässig et al. (1996: 61), Nässig & Schulze (1997: 150) and Beck & Nässig (2008: 161) the authors expressed their problems to find any reliable characters to distinguish ♀♀ of *A. diehli* from *A. borneensis* (and related species).

Figs. 1–3: ♀♀ of *A. diehli*. **Figs. 1, 2:** Kalimantan (CDRN). **Fig. 1:** dorsal view. **Fig. 2:** ventral view. **Fig. 3:** ♀, Kalimantan Tengah, Mt. Payang, 400–800 m, dorsal view (CSNB). — **Figs. 4, 5:** *A. borneensis*, ♀ holotype, South Borneo (BMNH). **Fig. 4:** dorsal view. **Fig. 5:** ventral view. — **Figs. 6–9:** ♂♂ of *A. diehli*. **Figs. 6, 7:** ♂, yellow form, Brunei, Temburong, 300 m (CDRN). **Fig. 6:** dorsal view. **Fig. 7:** ventral view. **Fig. 8:** ♂, orange form, Indonesia, Kalimantan Selatan, 30 km E Kandangan, 1100 m, dorsal viev (CSNB). **Fig. 9:** ♂, grey form, East Malaysia, Sabah, Danum Valley (SMFL). — Specimens not to the same scale; scale bar = 1 cm. — Specimens not to the same scale; scale bar (where present) = 1 cm. — Photographs: Figs. 1, 2, 6, 7: D. Rolfe. Figs. 3, 8: S. Naumann. Figs. 4, 5: I. J. Kitching. Fig. 9: J. Beck.

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The note by Paukstadt et al. (1998: 322) that *A. diehli* respectively *A. borneensis* ♀♀ are lacking distinguishing characters, is thereby disproved. In the same paper *A. helferi borneensis* is mentioned as questionable taxon, which either could be conspecific with *A. helferi* itself or being a senior synonym of *A. diehli*. The herewith figured ♀ holotype of *A. borneensis* (Figs. 4, 5) shows that both proposals have to be rejected.

While the only known ♀♀ are of intensive yellow ground colour, ♂♂ of *A. diehli* can be of yellow (Figs. 6, 7; see also Allen, 1981: pl. 9, Lampe 1984 & 1985: pl. 4, fig. 2; Holloway 1987: pl. 13, fig. 3; Nässig et al. 1996a: pl. 10, fig. 54; specimens in CDRN, CSNB), orange (Fig. 8; see also Lemaire 1979, holotype; Nässig & Beck 2005: fig. 1; specimens in CSLL, CSNB), or greyish brown colour (Fig. 9; see also Nässig & Beck 2005: fig. 2). *A. diehli* is a typical representative for the fauna of lower to medium elevation tropical rainforests and was collected in altitudes from 30 to 1100 m above sea level. They bear no resemblance to the fauna of the Cameron and Genting Highlands of West Malaysia, as could be judged from the title of Lampe's publications (1984, 1985); in his work he cites his specimens as originating from Kampong Sahom, which is located in the lowlands of Perak Province.

So far only a single figure of preimaginals of *A. diehli* exists. Nässig et al. (1996b: 133, pl. 7, fig. 79) describe the fourth instar larva from a photo taken by T. Harman in 1989. The stock came from Borneo and was collected by M. G. Allen whose material clearly could be assigned to *A. diehli*. The caterpillar could not be reared to pupation. It shows a bluish green ventral colour, is quite hairy, and the head capsule is brown instead of green as known from other members of the *helferi*-group. Again, the note by Paukstadt & Paukstadt (2007: 226, 230) that the assignment to *A. diehli* was tentative and leads to confusion, cannot remain anymore.

Known data for *A. diehli*

Sumatra: ♂ holotype, 3 ♂♂ paratypes, [Indonesia, Sumatera Barat], Sumatra, région ouest, Padangsche Bovenlanden, est de Padang, Sungei Dareh, 700 m, 15. vii. 1977, leg. E. W. Diehl (MNHN). 1 ♂, Indonesia, Aceh, East Aceh, 500 m, viii. 1978, leg. E. W. Diehl (MNHN). – **Nias:** 1 ♀, Indonesia, [Sumatera Utara], South Nias, Lahusa, 50 km NE Telukdalam, 0°46' N, 97°51' E, 20 m, 3. iii. 1995, leg. F. Brüggemeier (in coll. F. Brüggemeier, Kranichfeld). – **West Malaysia:** 3 ♂♂, West Malaysia, [Perak], Kampong Sahom, ii. & viii. 1982 (CRLN, 1 now in SMFL). – **Borneo:** 2 ♂♂, East Malaysia, Sabah, Danum Valley, 4.965°N 117.796°E, 220 m, 23. iii. & 16. xii. 2003, leg. J. Beck (SMFL). 4 ♂♂, 2 ♀♀, Brunei, Ulu Temburong, 300 m, 1. viii., 1. ix. & 9. ix. 1978, 20. vii. 1979, leg. M. G. Allen. 2 ♂♂, Brunei, Labi, 50 m, leg. M. G. Allen. 2 ♂♂, Brunei, Ulu Belait, 70 m, 23. i. 1979, leg. M. G. Allen (probably now in BMNH, at least partly). 1 ♂, Brunei, Temburong, 300 m, 22. ii. 1982, leg. T. W. Harman (CDRN). 1 ♂, Brunei, Rampayoh, near Labi, 30 m, 3. iii. 1982, leg. T. W. Harman, ex coll. CDRN (CSNB). 1 ♂, Brunei, Ulu Temburong, rainforest, 450 m, 28. iv. 1981, leg. M. G. Allen (CSNB). 1 ♂, Indonesia, Kalimantan Selatan, 30 km E Kandangan rainforest, 15 km NE Loksado, 1100 m, 2°52' N, 115°38' E, i. 1998, ex coll. A. Schintlmeister, genitalia no. 784/02 Naumann, barcode SNB 0050 (CSNB). 4 ♂♂, same data (CSLL). 1 ♀, Kalimantan [without further data; *cf.* pers. comm. T. W. Harman: Brunei], barcode SNB 1134 (CDRN). 5 ♀♀, Indonesia, Kalimantan Tengah (Central Kalimantan), Mt. Payang, 400–800 m, iii. 2008, leg. local collector, via S. Jakl (CSNB). 1 ♀, same data, ex CSNB (CDRN).

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Buchbesprechung

Thomas J. Witt („Editor-in-Chief", Serienherausgeber): **The Witt catalogue. A taxonomic atlas of the Eurasian and North African Noctuoidea.** Bisher 2 Bände erschienen:

Ronkay, L., Ronkay, G., & Behounek, G. (2008): **Volume 1. Plusiinae I.** — Budapest (Heterocera Press), 348 S., 50 Farbtafeln, davon 38 Tafeln stark vergrößert, von wohl jeder Art und jedem Geschlecht in der Regel ein Exemplar, und 12 Tafeln in etwa natürlicher Größe mit Variationsbreite, 150 stark vergrößerte Genitalabbildungen. ISBN 978-963-88014-0-1. Preis 128,00 €.

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Die Namen der Autoren und das Thema sind den Lesern geläufig: Die Serie „Noctuidae europaeae" ist noch nicht ganz abgeschlossen, da stürzen sie sich schon wieder auf den erweiterten Kreis der gesamten Paläarktis und „Eurasiens". Diesmal mehr Arten, mehr Familien (Noctuoidea, nicht nur Noctuidae!), mehr schöne Bilder — aber bisher auch preiswerter als der Durchschnitt der europäischen Bearbeitung.

Die beiden Bände sind ähnlich aufgebaut: Nach einem Vorwort, allgemeinen Seiten (mit Abkürzungserklärung und Danksagung) und einer sehr knappen taxonomischen und nomenklatorischen Zusammenfassung folgt der Systematische Teil mit der Abhandlung der ca. 132 Arten bei den Plusiinae (davon 7 im Werk neubeschriebenen) nebst etlichen Subspecies beziehungsweise ca. 126 Arten bei den Cuculliinen (davon 6 neuen) nebst Unterarten. Die Textbearbeitungen beschränken sich leider (wie beim Vorbild „Seitz") auf reine „Museumsdaten"; außer morphologischer Diagnose und einer kurzen Verbreitungsangabe in Wörtern werden keine weitergehenden Informationen geliefert, Hinweise etwa zu Biologie und Nahrungspflanzen, Phänologie, Ökologie etc. fehlen, auch da, wo man es schon weiß. Es folgen die Falterfarbtafeln: zuerst je ein ♂, ein ♀ [wohl von jeder Art? Ich habe es nicht einzeln nachgeprüft] vergrößert, danach Faltertafeln in ungefähr natürlicher Größe mit kleinen Variationsserien, gefolgt von den stark vergrößerten Genitaltafeln. Ein Literaturverzeichnis und ein Index runden jeweils den Inhalt ab.

Bei etlichen der „normalgroßen" Farbtafeln in den mir vorliegenden Exemplaren scheint der Vierfarbdruck etwas „geflattert" zu haben, oder der gewählte Raster ist etwas zu grob; die Tafeln sind jedenfalls teilweise irgendwie nicht ganz scharf. Auch die Ausleuchtung der Tafeln im Randbereich oben und unten ist nicht immer optimal. Schade, denn viele der abgebildeten Arten sind den Noctuidenfreunden in Europa sicher bisher weitgehend unbekannt und hätten einen noch besseren Farbdruck verdient, und die Serie wirbt damit, „wundervolle Bücher, die man mit Freude in die Hand nimmt", zu produzieren. Immerhin, die vergrößerten Fotos erfüllen diesen Anspruch.

Das Projekt ist sehr ambitioniert; im Generalvorwort wird von „60 Bänden" allein für die Noctuidae im klassischen Sinn (ohne andere Noctuoidea-Familien) und „einem Nachfolger des Seitz-Werkes" gesprochen; zukünftig sollen etwa 2 Bände pro Jahr erscheinen.

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